

# **TIME STEP ISSUES IN IGSM2**

**IGSM2 User's Group Meeting**

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**California Department of Water Resources**



# Time Step Issues in IGSIM2 :

- Extended run times when calibrating with a daily time step
- Monthly data (e.g. ET) is not consistent with daily data (e.g. precipitation) when divided by 30
- Difficult to analyze the simulation results when output is given for simulation days (stream flow at day 12345???) instead of corresponding date/time



# Simulation Time Step

- General Mass Balance Equation:

$$\frac{\Delta S}{\Delta t} = \text{In} - \text{Out}$$

- IGSM2 takes  $\Delta t$  as 1.0 but it does not know what it really represents (hour, day, month?)
- User is guided to convert the units of time into day through conversion factors in input data files
- In output files the value 1.0 for  $\Delta t$  is “*tagged*” with the unit “day”



# Questions:

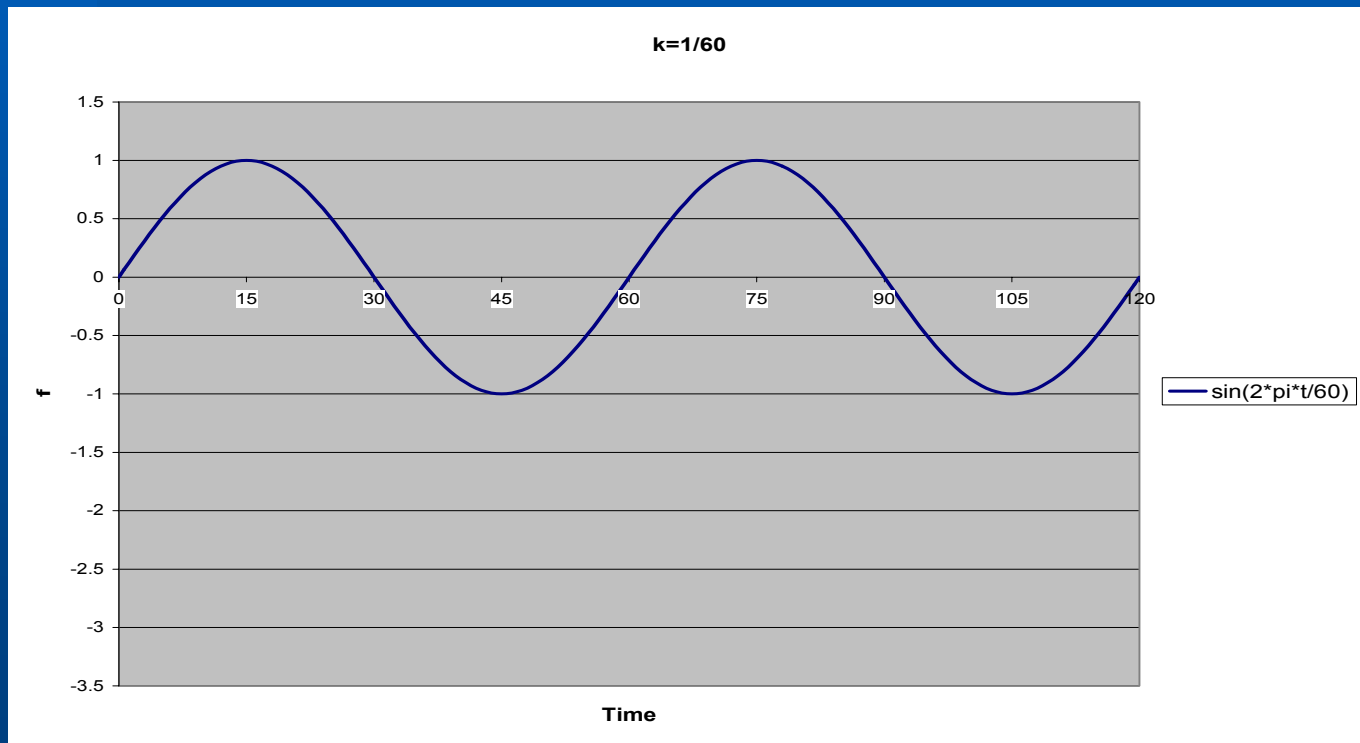
- Can any unit for  $\Delta t$  be used freely?
- Can one calibrate IGSM2 with a particular  $\Delta t$  and perform projection runs with another  $\Delta t$ ?



# Analogy:

$$\frac{df}{dt} = g(t) ; f(0) = 0 \text{ where } g(t) = 2\pi k \cos(2\pi kt)$$

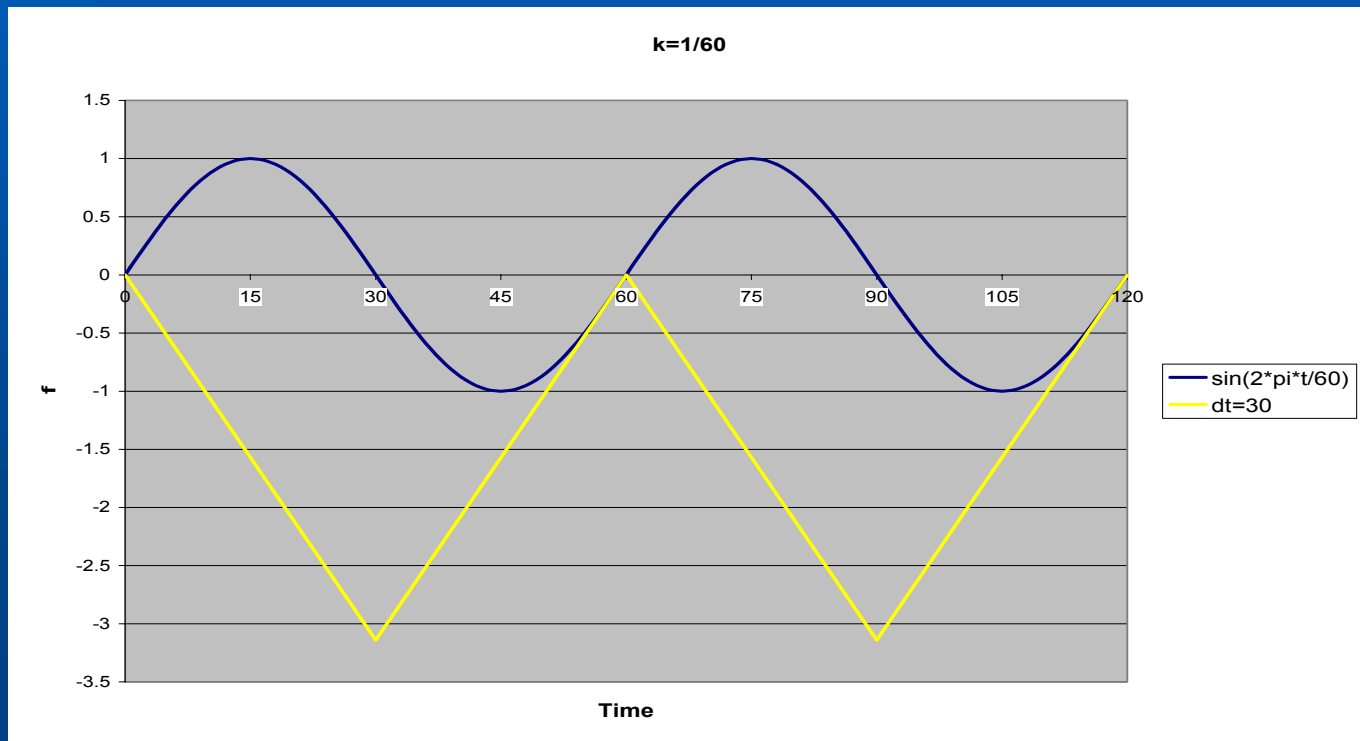
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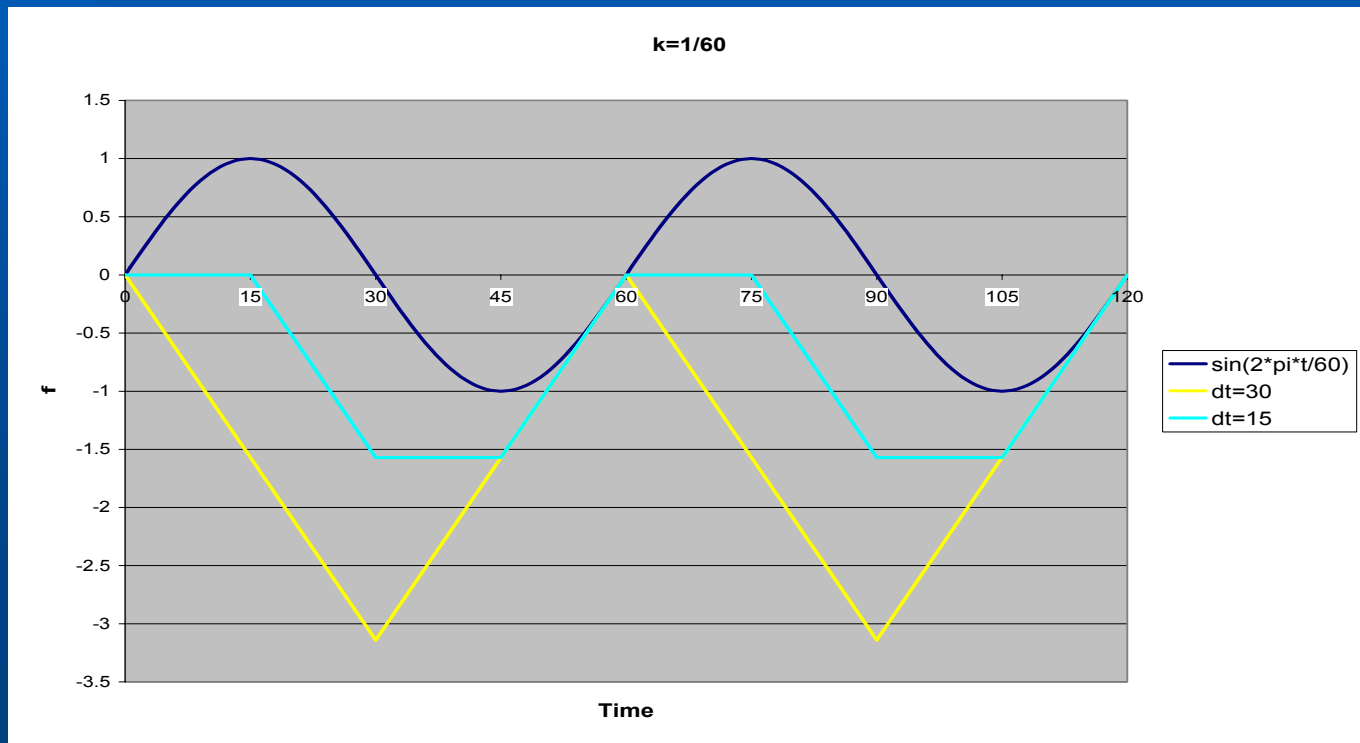
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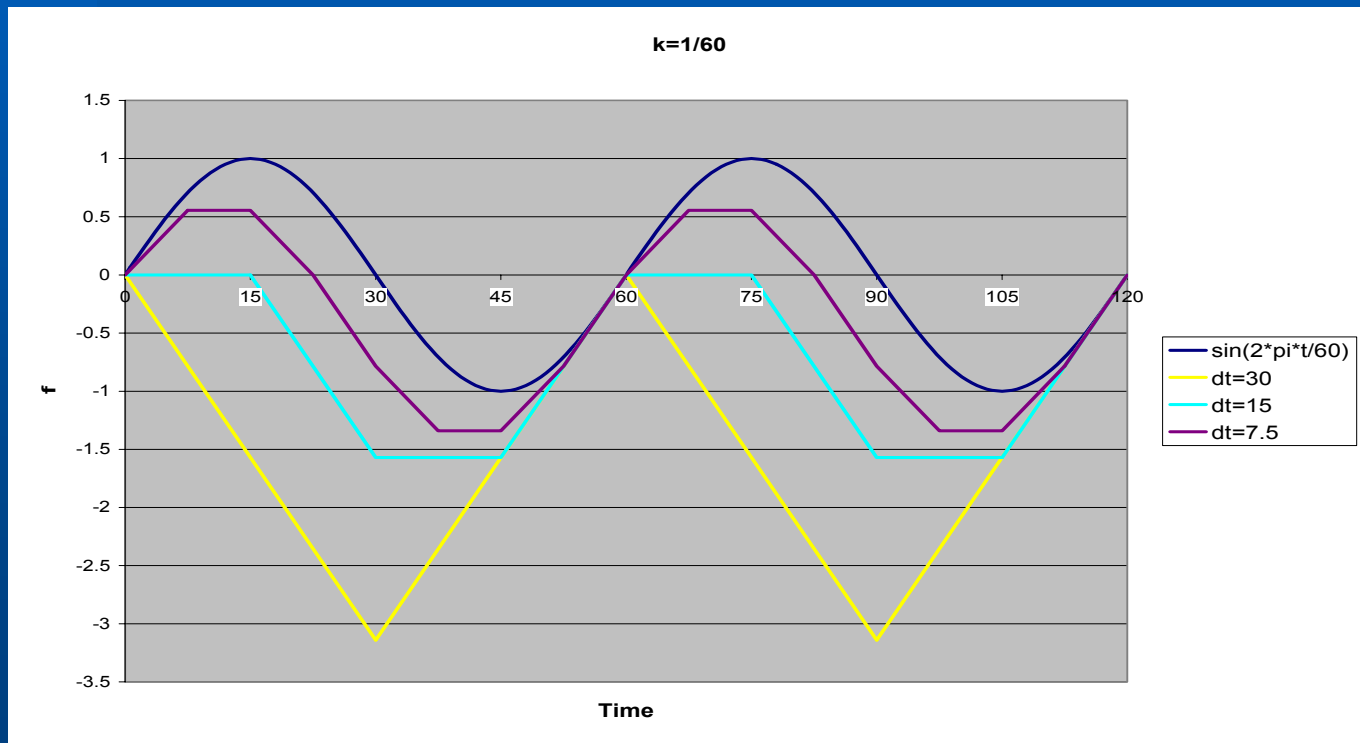
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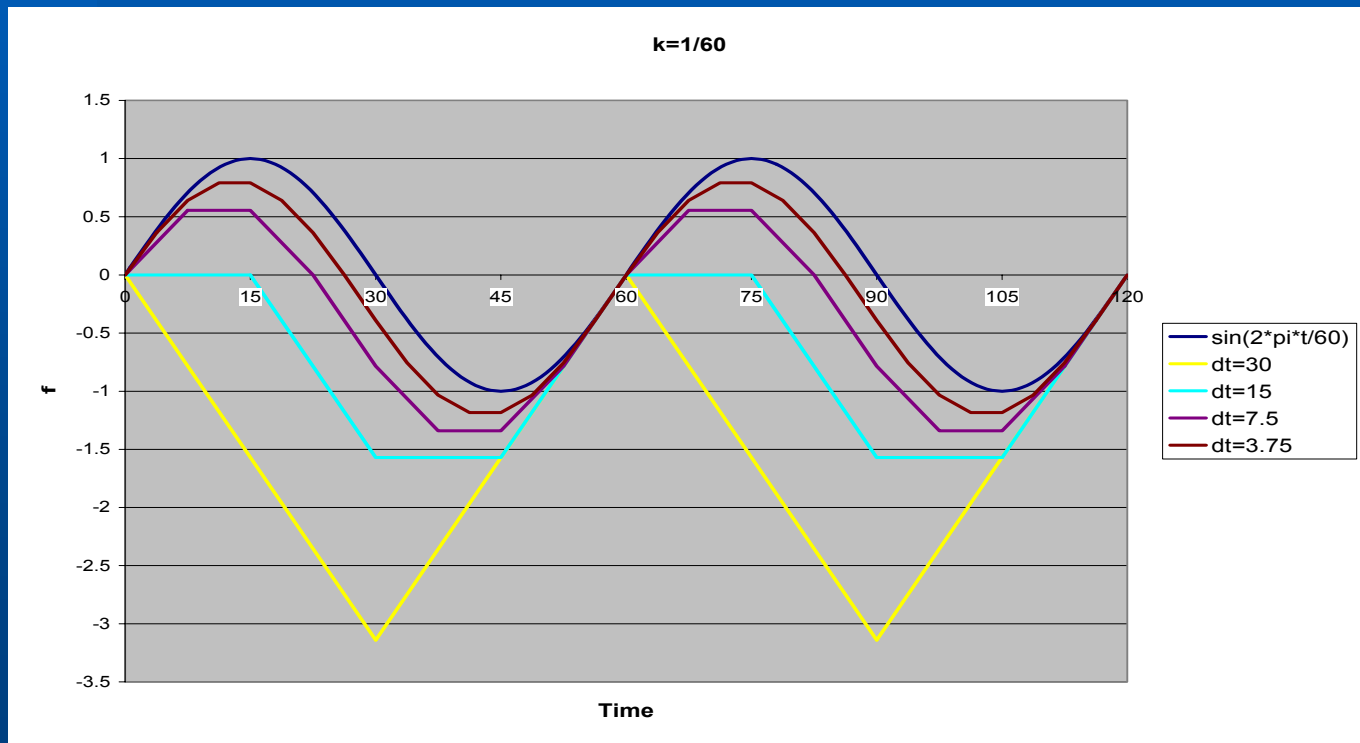




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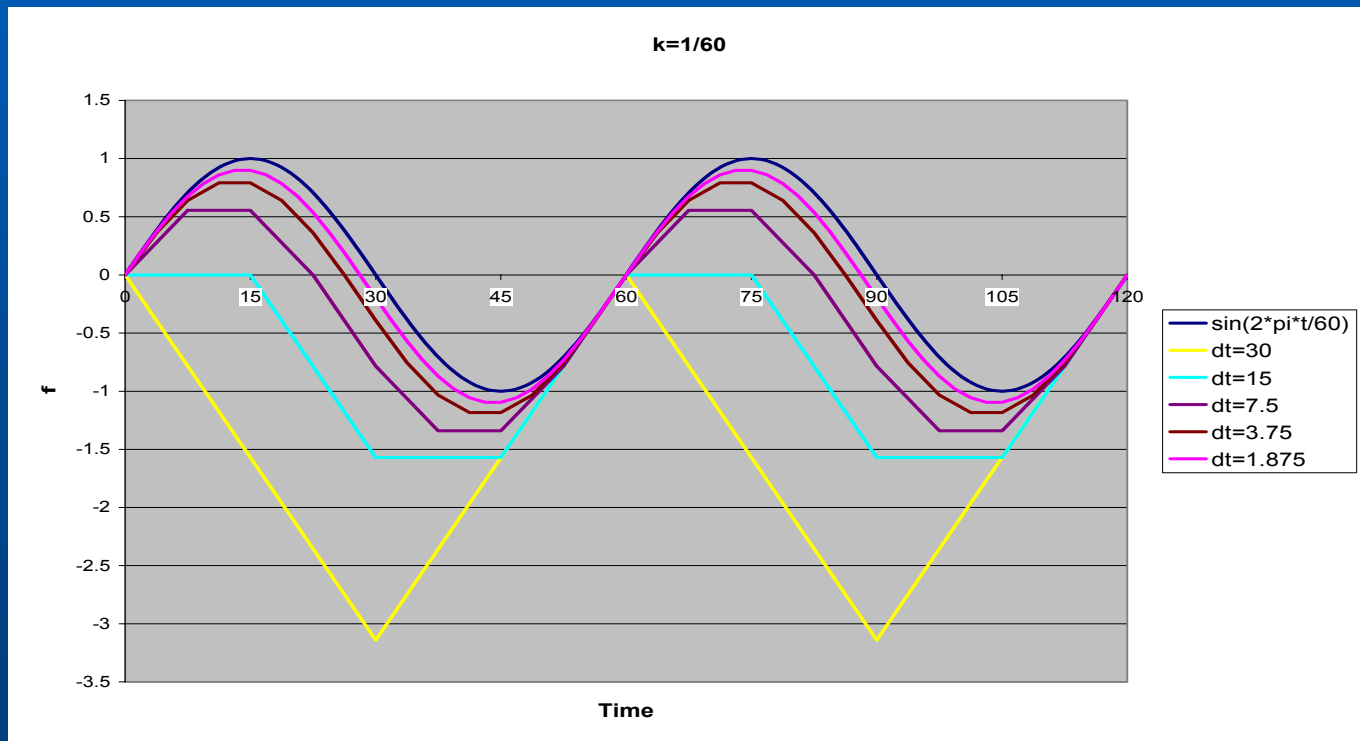
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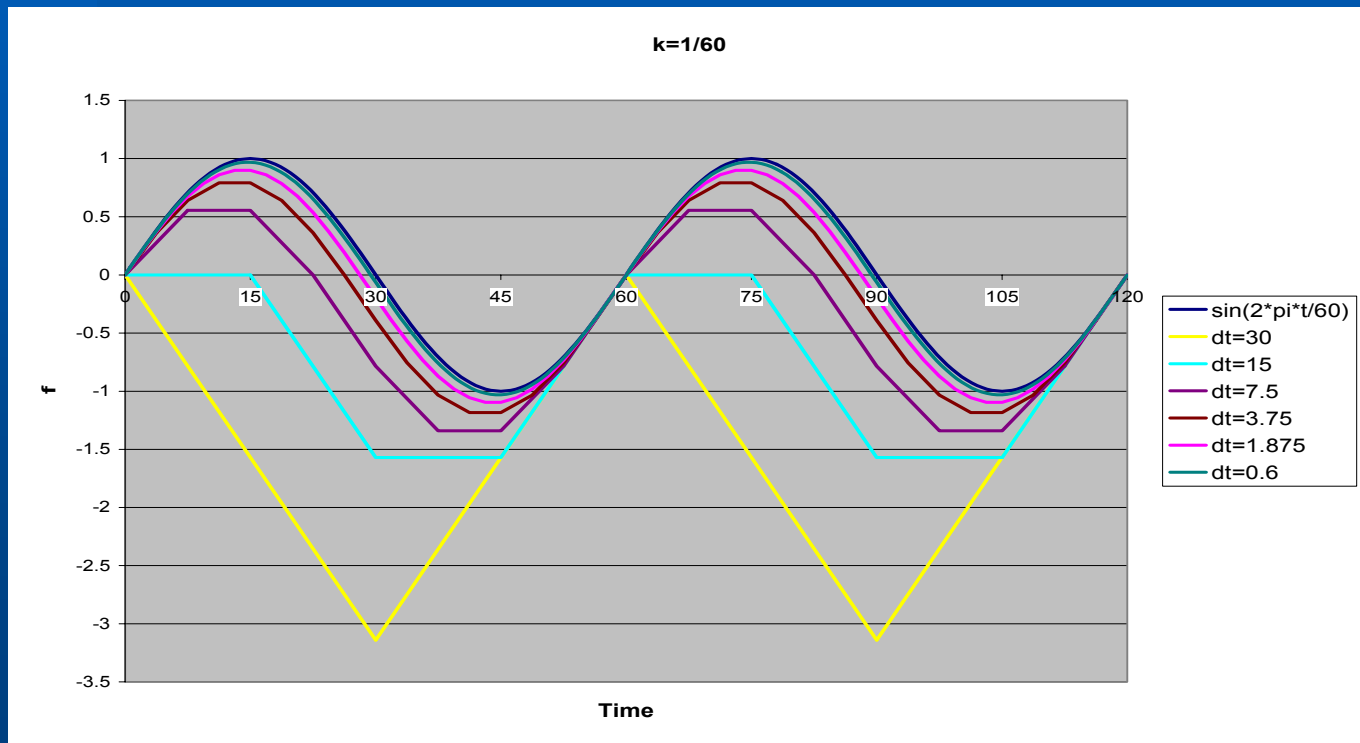
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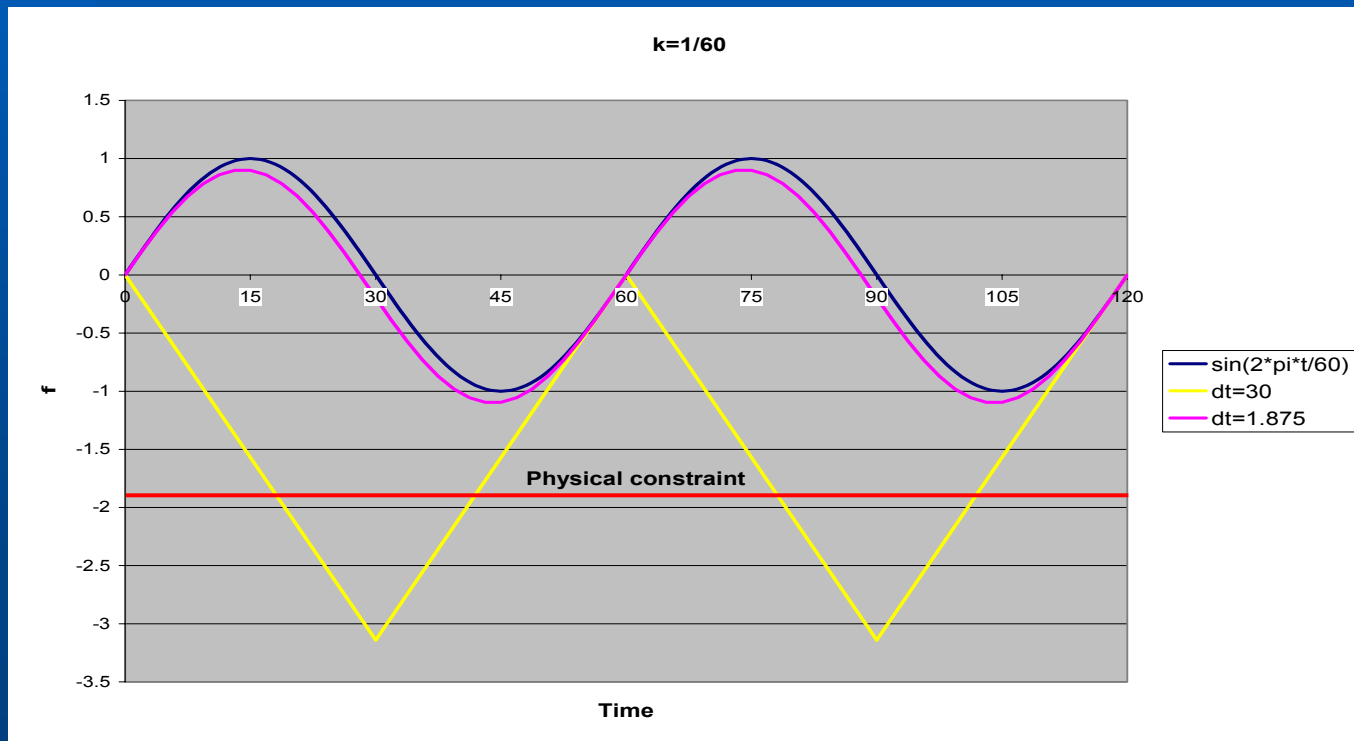
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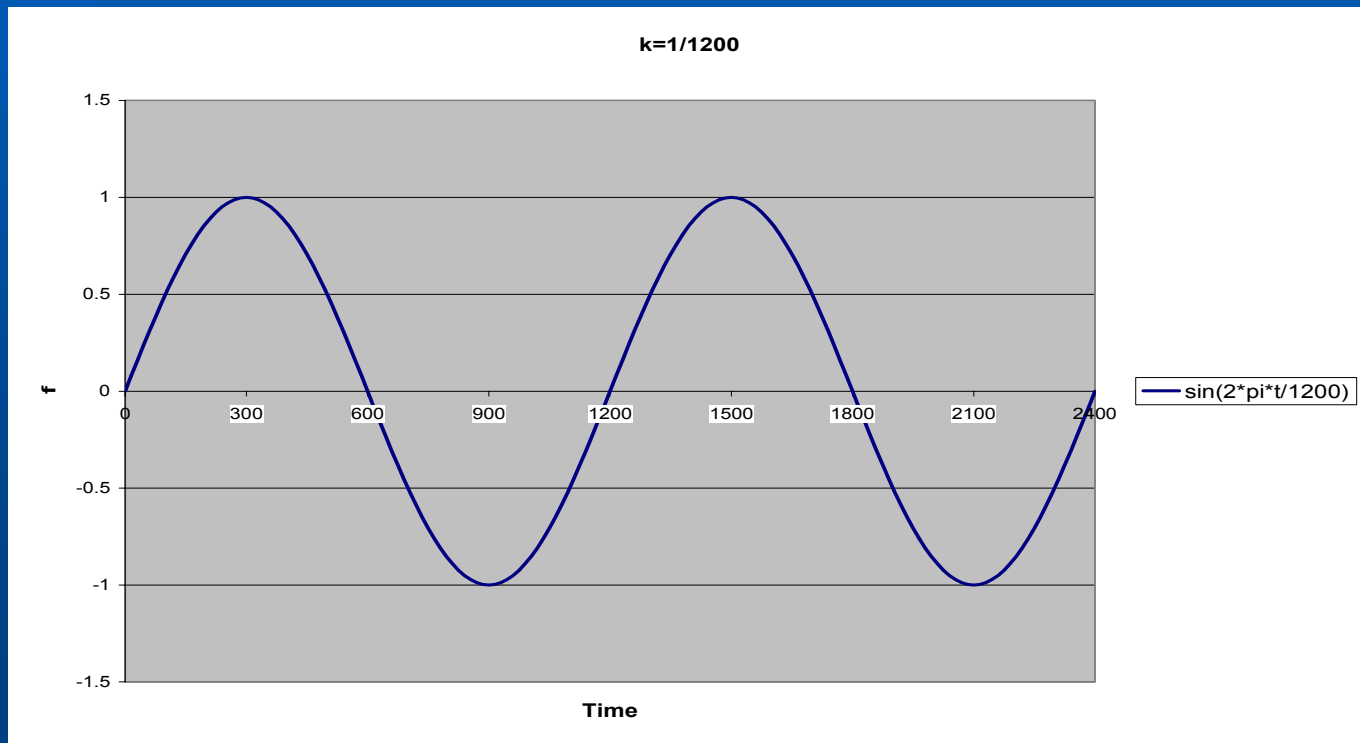
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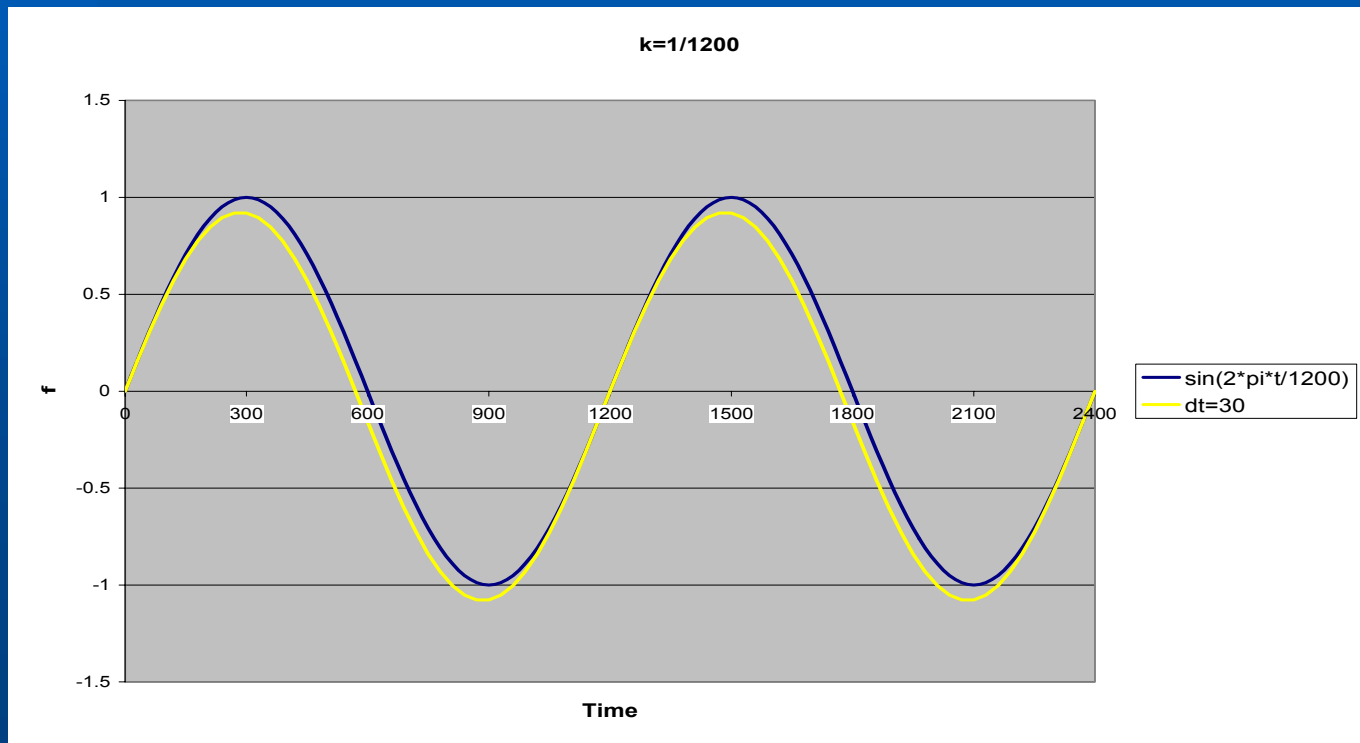
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# Comments:

- $\Delta t$  should be smaller than the characteristic time scale of the process being simulated
- The model may be calibrated with a  $\Delta t$  larger than the characteristic time scale of the process, but calibration values might generate erroneous results with a smaller  $\Delta t$
- With a too large of  $\Delta t$ , the numerical results may be stable but constraints due to the physical nature of the process may create instabilities when coupled with these “*physically meaningless*” numerical results



# Time Step Issues in IGSM2 (from 1<sup>st</sup> slide):

- **CONCERN:** Monthly data (e.g. ET) is not consistent with daily data (e.g. precipitation) when divided by 30
  - IGSM2 does not assume a month is 30 days, a year is 360 days, etc. It is up to the user (through NSP\_ and NFQ\_ variables in data files) to choose the distribution factor in order to distribute data uniformly over smaller time periods (e.g. monthly data into daily data)
  - User is free to generate his/her own daily data (using actual number of days in each month) outside IGSM2 and use this data directly without any manipulation by IGSM2





# Time Step Issues in IGSM2 (from 1<sup>st</sup> slide):

- **CONCERN:** Difficult to analyze the simulation results when output is given for simulation days (stream flow at day 23456???) instead of corresponding date/time
  - This is a database issue and can be handled by pre and post processors instead of modifying IGSM2 engine



# Issues on Data Input and Output of Results

- **Examples of available data sets (from CVGSM):**
  - *ET* (monthly; specified for 12 months; same monthly values are used for the entire simulation period; October data is listed first)
  - *Precipitation* (monthly b/w Jan. 1922 – Dec. 1945, daily b/w Jan. 1 1946 – present; occasional missing data due to gage malfunction)
  - *Crop acreages* (annual; values are updated on October 1 of every year)
- **Simulation requirements:**
  - $\Delta t = 1$  day
  - Simulation period = January 1, 1922 – December 31, 1998
  - Cumulative / instantaneous output of simulation results at the end of each month



# Issues on Data Input (based on previous example)

- Filling in the missing data in precipitation file
- Conversion of monthly precipitation and monthly ET data to daily data (considering actual number of days in each month, leap years, etc.)
- Arrangement of crop acreage data so that it can be used with a daily simulation
- Arrangement of newly generated daily ET and precipitation data, and annual crop acreage data so that the first data value in each data set corresponds to January 1, 1922



# Issues on Output of Results

(based on previous example)

- Association of simulation time step with the actual date/time in simulation period
- Based on the time step-date association above, output instantaneous simulation results at the end of each month (i.e. on Jan. 31, 1922; Feb. 28(29), 1922; Mar. 31, 1922, etc.)
- Based on the time step-date association above, aggregate the simulation results and output the monthly cumulative values



# Thoughts on Addressing the Issues of Data Input and Output

- Use a database system designed for the storage and handling of time series data (e.g. HEC-DSS)
- Develop pre and post processor utility programs to handle data input, conversion and manipulation
- At this stage develop algorithms for pre and post processors to use 1 hour, 1 day, 1 month or 1 year for possible data input and output time step
- On input, supply simple algorithms to distribute data over smaller time step (e.g. uniform distribution of monthly data to daily data), to estimate missing data (e.g. linear interpolation), etc.



# Thoughts on Addressing the Issues of Data Input and Output *(continued)*

- On output, allow the user only to aggregate simulation results (hourly to daily, hourly to monthly, daily to monthly, etc.)
- Continue to support data input and output options based on simulation time step (opposed to matching date/time) to allow independent and adventurous user to utilize a variety of time steps
- Avoid excessive modifications to IGSM2 engine itself to perform data input and output (i.e. keep IGSM2 as general as possible)
- Work with the users and urge them for their input in order to develop a practical data input/output system

